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CONTENTS

The Leukemias
Russell L. Haden, M.D. 55

Intramedullary Fixation of Certain Fractures of Both Bones of the Forearm
James A. Dickson, M.D. 62

Protrusion of Intervertebral Disk, A Common Cause of Sciatica
W. James Gardner, M.D. 66

Paget's Disease of Skull Complicated by Mucocele of Frontal Sinuses
Harold E. Harris, M.D. 74

Reticulum Cell Sarcoma of Jejunum
R. S. Dinsmore, M.D., and V. C. Ancona, M.D. 77

Narcolepsy and Cataplexy
R. H. McDonald, M.D. 79

Medical Physics II, Radiation Therapy
Otto Glasser, Ph.D. 83

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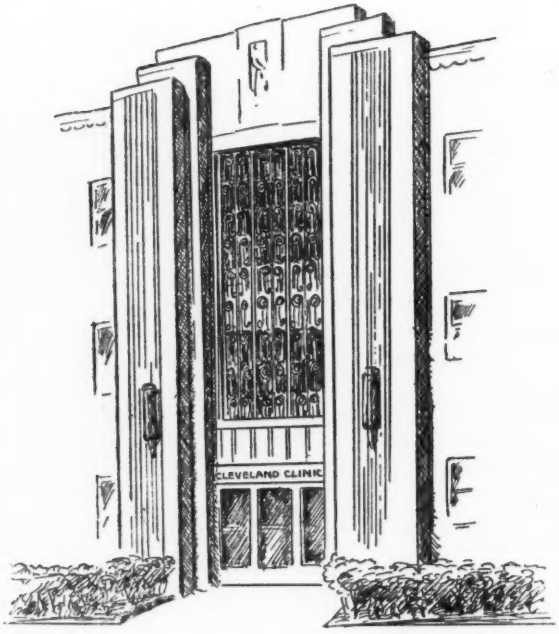

CLEVELAND CLINIC

THE LEUKEMIAS

RUSSELL HADEN, M.D.

Leukemia is a fairly common blood dyscrasia characterized by unrestrained overgrowth of tissues which normally form leukocytes, as well as by areas of leukopoietic proliferation in other parts of the body. There is much to indicate that it is a neoplastic disease. Although the length of life of patients with leukemia varies greatly, the disease always ends fatally. Different types of leukemia may present such widely varying clinical pictures that many diseases are suggested.

During the past thirteen years 357 patients with leukemia have been studied in the Cleveland Clinic. Detailed blood studies in all cases were made in the hematology laboratory, and bone marrow preparations were studied when indicated. When a blood examination shows a definite leukemia, a bone marrow film only confirms the diagnosis; but when the diagnosis from the blood examination is difficult because of leukopenia or a scarcity of immature cells, the marrow findings may be diagnostic. All blood and marrow preparations are kept in a permanent file for review.

INCIDENCE

The exact distribution of the 357 cases according to the five types of leukemia is as follows: monocytic 52, acute myeloid 60, chronic myeloid 90, acute lymphoid 54, chronic lymphoid 101.

I analyzed in detail 250 of the 357 case histories, or 50 consecutive cases of each of the five types. In this survey almost all the monocytic, the acute myeloid, and the acute lymphoid cases were included. Consecutive cases of chronic myeloid and chronic lymphoid leukemia were taken to insure a fair sample.

Men are more susceptible to the disease than women. In the 250 cases the proportion is almost 2 to 1 (62.8 per cent to 37.2 per cent). Every age is represented.

Every decade is included in the monocytic group. One infant with monocytic leukemia was only 3½ months old when the diagnosis was made, and several patients were 70 or over. The chronic lymphoid type is most common between 50 and 70; no patients were under 20, and only 2 patients were under 40. However, 80 per cent of the cases of acute lymphoid leukemia occurred under the age of 20. Chronic myeloid leukemia occurs most frequently between 40 and 60. In this series, however, all decades were represented. One child 2½ years of age had typical chronic myeloid leukemia. The acute myeloid cases were evenly distributed in all decades.

DIAGNOSIS

All types of leukemia present two fundamental characteristics, toxemia and infiltration. The signs and symptoms may be due to a combination of the two processes or entirely to one or the other.

The more important symptoms of toxemia are fever, loss of weight, sweating, anorexia, malaise, and joint pain and swelling. The exhaustion common to all types of leukemia is due partly to toxemia and partly to anemia. In most cases the anemia seems to be the result of overcrowding of the marrow spaces by leukopoietic overgrowth, preventing normal red cell formation. However, toxemia, because of its depressing effect on the bone marrow, is often a factor in the anemia. Especially in acute cases the marrow may be even aplastic although immature, making the differentiation of primary aplastic anemia and leukemia most difficult. The aplasia can be explained only on the basis of a toxic effect on the bone marrow.

Hyperplasia and infiltration of tissues and organs everywhere in the body are always present in leukemia. The enlarged spleen and lymph glands represent an increase in the size of normal organs and tissues through overgrowth of white cell-forming tissues. The bone marrow is usually hypertrophied. The marrow which normally forms leukocytes is overcrowded. The part of the marrow which normally shows little activity—as in the long bones—also becomes hyperplastic and overgrown with leukocytes of different types. White cells may multiply anywhere in the body either by metaplasia or by localization through the blood stream and subsequent multiplication.

Other important fundamental changes which depend on toxemia and infiltration of tissues are anemia, hemorrhage, and infection.

The almost constant occurrence of anemia from toxic depression of bone marrow activity, crowding out of erythrogenic tissue by overgrowth of white cells, or a combination of these factors has already been mentioned. Hemoglobin as high as 80 per cent was found in only 24 of the 250 patients, and only 3 patients had acute leukemia without anemia. Most patients without anemia had chronic lymphoid leukemia. The anemia is the cause of weakness and shortness of breath complained of by many patients as well as pallor.

Hemorrhage is frequent in all types of leukemia and may occur in any part of the body. In some patients the tendency to abnormal bleeding is due to platelet deficiency, in others to increased permeability of the vessels without thrombopenia, and in still others to a combination of these two factors. Abnormal bleeding is commonly manifested as petechiae, especially in acute leukemia. Gross bleeding in the brain or from the intestinal tract is not uncommon. Cerebral hemorrhage is a

frequent cause of death in chronic myeloid leukemia in which the number of platelets is usually increased. Hemorrhage may be difficult to control even by transfusion.

Increased susceptibility to infection is prominent. This occurs most frequently in acute leukemia in which leukopenia is common and mature polymorphonuclear cells in blood and tissue are greatly reduced. In the absence of normal defense cells, resistance to bacterial infection is very low. Common sites of infection are around the teeth and gums and in the tonsils and rectum. Infection may be a factor in the fever usually present.

Because leukemia is a disease of the blood-forming organs, the diagnosis must finally be based on changes in the circulating blood and in the bone marrow. Anemia is an almost constant finding, and it is usually marked in every acute or serious case of leukemia. The patient who does not have an anemia has either mild chronic lymphoid leukemia or early chronic myeloid leukemia. The anemia may be of any type, but a marked microcytic or hypochromic anemia is seldom encountered unless blood loss has been severe. In many cases the anemia is definitely macrocytic, especially in the patient with leukopenia, and pernicious anemia may be suspected. The macrocytosis of leukemia is not adequately explained. An increased volume of red cells is believed to indicate a deficiency in supply or a lack of use of the erythrocyte-maturing factor present in liver extract. In leukemia the supply of the specific maturing factor is evidently adequate, since the anemia is not improved by treatment with the specific maturing principle. The disease probably interferes with utilization of the specific substance in the bone marrow.

A number of cases of hemolytic anemia were encountered, several of which were spherocytic, suggesting congenital spherocytosis. In one case the spleen was removed before leukemia was recognized.

The platelets are extremely variable, but in acute leukemia are often so low that thrombopenic bleeding occurs. In about 10 per cent of these cases abnormal bleeding, usually due to thrombopenia, was the most important symptom. The thrombopenia may be due to crowding out of the megalokaryocytes in the marrow or to depression of marrow function by toxemia.

Study of the white cell is the most important part of the blood examination; in the last analysis the diagnosis of leukemia must rest on abnormalities in the leukocytes. Leukocytosis is always associated with leukemia and is often considered necessary for the diagnosis, but the type of leukocytosis is extremely variable. Of these 250 cases the white cell count on admission was below 6000 per cu. mm. in 27.6 per cent, from 6000 to 10,000 in 6.8 per cent, and over 10,000 in only 65.6 per cent of the patients. Thus, leukocytosis was present in only two-thirds of the

patients. The white cell count for the 357 patients was much the same; in 32.2 per cent the white cell count was under 10,000 per cu. mm., and in 67.8 per cent over 10,000. In many cases of leukocytosis the count was not very high, although occasionally a very high count was found. One patient with chronic lymphoid leukemia had a count of over 2,000,000 white cells on numerous occasions, and at times this patient's white cell count was higher than the red cell count. Many seriously ill patients never had a white cell count above 1000. In all cases with leukopenia, however, the bone marrow is immature and usually hyperplastic. For this reason patients are said to have leukopenic leukemia rather than aleukemic leukemia.

Usually the differential count of leukocytes reveals immature cells. In myeloid leukemias these may be the intermediate series: myelocytes, promyelocytes, metamyelocytes, and myeloblasts. Intermediate cells may be seen in various conditions, but myeloblasts, monoblasts, and lymphoblasts are probably seen only in myeloid leukemia.

Often not enough white cells are available for study to find many immature cells. Here concentrated preparations of leukocytes are of the greatest value. These are simply prepared by allowing the red cells to settle out by gravity for a short time, centrifuging quickly, and making films from the buffy coat, or layer of white cells on the surface of the red cells. In this way any number of white cells can be obtained for microscopic study, and blasts and immature cells are easily found.

The cells in the circulating blood, however, only reflect the activity of the bone marrow in which the leukocytes are formed. A biopsy of bone marrow may be obtained by trephining the sternum or some other bone. In most cases an entirely satisfactory specimen of the marrow may be obtained by aspirating the sternal marrow with a large needle and making coverslip preparations with the material obtained. When the diagnosis of leukemia is difficult, it may be confirmed by examination of the marrow; in all doubtful cases study of the bone marrow is mandatory.

CLINICAL FEATURES

The clinical features of different types of leukemia are of primary interest. In all types the complaints vary widely. Anemia and weakness were the outstanding features of the clinical picture in patients with **monocytic leukemia.** Fever alone or with anemia was prominent and was often associated with generalized body aching. Two other prominent symptoms are infection and abnormal bleeding. The infection most often involves the buccal tissues, so that the diagnosis can often be made from the condition of the gums and other tissues of the oral cavity alone. Hypertrophy of the gums is especially characteristic and may progress

very rapidly, usually with necrosis. The necrosis may become chronic and persist for months. Other patients, equally typical of monocytic leukemia insofar as the hematologic diagnosis is concerned, may never show infection of any kind. Abnormal bleeding may be very severe and difficult to control. It is most likely to occur in patients with evident toxemia as manifested by fever and anemia and may progress rapidly. Bleeding here is usually the result of thrombopenia.

The clinical picture of monocytic leukemia varies more than that of any other type. One patient was admitted recently to the dermatological service with multiple skin ulcerations previously diagnosed and treated as furunculosis. The patient had a persistent fever. Until the blood examination leukemia was not suspected. The blood examination showed 20,000 leukocytes with many monocytes and monoblasts. Severe anemia was also present. Sternal puncture revealed hyperplastic marrow with a great excess of monocytes. Biopsy of a local lesion confirmed the diagnosis of monocytic leukemia. Another patient who had only a marked anemia during the course of his disease lived several years with multiple transfusions. There was no leukocytosis, although a high proportion of the cells were monocytes. The anemia was always macrocytic. Many other equally unusual clinical histories could be detailed. The youngest patient I have seen with leukemia was 3½ months old and had the monocytic variety. One-half the patients in this group were over 45 years of age.

The leukocyte count in monocytic leukemia is seldom high. Sixty per cent of this group never had a count above 10,000. Only 3 patients had a count over 100,000. The anemia was macrocytic in almost one-half the cases in which the volume index was measured. The spleen and glands were seldom enlarged. In some cases blasts were never seen.

Acute leukemia runs a more rapid course and is characterized by the presence of more immature cells in the blood and marrow.

Acute lymphoid leukemia occurs principally in children; the disease is rare in older persons. Two-thirds of the patients in this group were under 10 years of age. I have been impressed with the frequency of occurrence of skeletal pains in acute lymphoid leukemia. Several patients had definite arthritis. One boy of 7 had marked swelling of an ankle and intense pain in the legs. Involvement of most of the large joints confined him to bed for two months before admission. The arthritis was associated with fever and anemia.

The outstanding characteristics of the acute lymphoid type are anemia and weakness and an abnormal tendency to bleeding, usually manifested by easy bruising. The spleen was enlarged in most cases. The patients complained of enlarged glands, but the enlargement was mini-

mal. Perhaps this group follows the textbook description more closely than any of the other groups. When a child presents fever, anemia, easy bruising, and enlarged glands and spleen, the diagnosis is usually acute lymphoid leukemia. Here again leukopenia is common, although very high counts are also observed. Anemia is always present and usually severe. The anemia is seldom macrocytic, often microcytic.

Acute myeloid leukemia has much in common with the acute lymphoid type. The patients in this group were older. All decades from the first to the seventh were represented, but only 6 patients were under 10. The other cases were quite uniformly distributed over the 10-70 interval. The presenting complaints were perhaps the most varied of all groups. Among these were chills and fever, enlarged spleen, swelling of the face, stomach trouble, sore throat, weakness, pernicious anemia, joint pain and swelling, loss of appetite, and fever. Actual joint involvement is much less common than in the acute lymphoid type. The outstanding clinical features are anemia and fever. Abnormal bleeding may be prominent but is infrequent. Infection is not so common as in the monocytic group. Necrosis occurs but is uncommon. The leukocyte count is seldom high. Two-thirds of the group of 50 patients had a leukocyte count under 10,000. In 3 cases no myeloblasts could be found in the blood, although the marrow showed the typical picture of acute myeloblastic leukemia. Less than half the patients had a palpable spleen. At times there was some general glandular enlargement.

In many instances **chronic lymphoid leukemia** is benign and has a prolonged course, although, as always, the disease ends fatally. It is a disease of older persons. I have never seen this type in a younger person. Eighty-eight per cent of the 50 patients in this group were over 50 years of age; only 3 were under 45. Often no blast cells were seen. Usually fragile cells or smudges were present and probably represented immaturity. Even in the mild chronic cases the bone marrow showed a high proportion of hybrid cells. Usually the total leukocyte count was high. Only one patient had a count less than 10,000. Many patients had no anemia. This is the only type of leukemia which persists for any length of time without development of anemia.

The clinical symptoms of chronic lymphoid leukemia also are often mild. Enlarged glands and spleen may be the only abnormality for a long time. Most patients who have had leukemia for any length of time belong in the chronic lymphoid group. This type not infrequently has been an incidental finding in the examination of patients. Patients entering the Clinic for chronic cough, iritis, abdominal pain, rheumatism, pain in the legs, headache, leukocytosis, bladder trouble, constipation, and "sick spells" have had chronic lymphoid leukemia. In most

cases the outstanding clinical feature was enlarged glands or spleen. Weakness was relatively uncommon. Infection as a complication was seldom encountered.

Chronic myeloid leukemia is characterized principally by weakness. This is partly due to anemia, which is almost always present, but the toxemic character of the disease is also an important causal factor in the exhaustion. Many patients were concerned about the enlarged abdomen resulting from a marked splenomegaly. Fever, which is very frequent, was the presenting complaint in several instances. One patient was confined to a tuberculosis sanatorium for months because an acid-fast infection was suspected when the fever was really due to leukemia. The tendency to bleed is greater in the chronic myeloid than in the chronic lymphoid type, probably because of the more severe toxemia. Here the abnormal hemorrhage is not due to thrombopenia but to the toxic effect of the disease on the endothelium of blood vessels. Usually the platelet count is high. Not infrequently hemorrhage is the cause of death. Infection is uncommon. In this group the patients' ages varied from 2½ to 76 years. Most patients were in the middle age group. Usually the total leukocyte count is high. In only three instances was it less than 10,000, and in over half the patients the count was above 100,000. Blasts were almost always found.

SUMMARY

Leukemia is a generalized disease and may affect any part of the body. It is characterized primarily by toxemia and cellular infiltration of organs and other body tissues.

The youngest patient in this series of 357 cases was 3½ months old and the oldest 76 years. Monocytic leukemia and acute myeloid leukemia affect persons of all ages. Acute lymphoid leukemia is most common in childhood, while chronic lymphoid leukemia and chronic myeloid leukemia are predominantly diseases of middle age.

The greatest variety of clinical pictures is encountered, so that there is little that is characteristic of the disease. The signs and symptoms are largely the result of anemia, hemorrhage, and infection due to toxemia and cellular infiltration. The bone marrow is always involved. It is usually hyperplastic but may be aplastic although immature.

Leukocytosis is often absent, especially in the acute types. In the entire group of cases the leukocyte count was below 10,000 in one-third of the patients. In 100 patients with acute lymphoid or acute myeloid leukemia the count was below 10,000 in over one-half of the patients.

Oral infection with hypertrophy of the gums is a prominent symptom in monocytic leukemia. The spleen is seldom palpable. The leukocyte count is usually not very high. The anemia is often macrocytic.

Acute lymphoid leukemia is characteristically a disease of childhood. Anemia, bleeding, and joint pain and swelling are frequent symptoms.

Acute myeloid leukemia occurs in all ages and is characterized by the greatest variety of symptoms and clinical findings.

Chronic lymphoid leukemia is often a very mild disease and runs a benign course. Enlargement of glands and spleen is the outstanding feature.

Chronic myeloid leukemia is characterized by marked toxemia causing almost constant fever and anemia.

INTRAMEDULLARY FIXATION OF CERTAIN FRACTURES OF BOTH BONES OF FOREARM

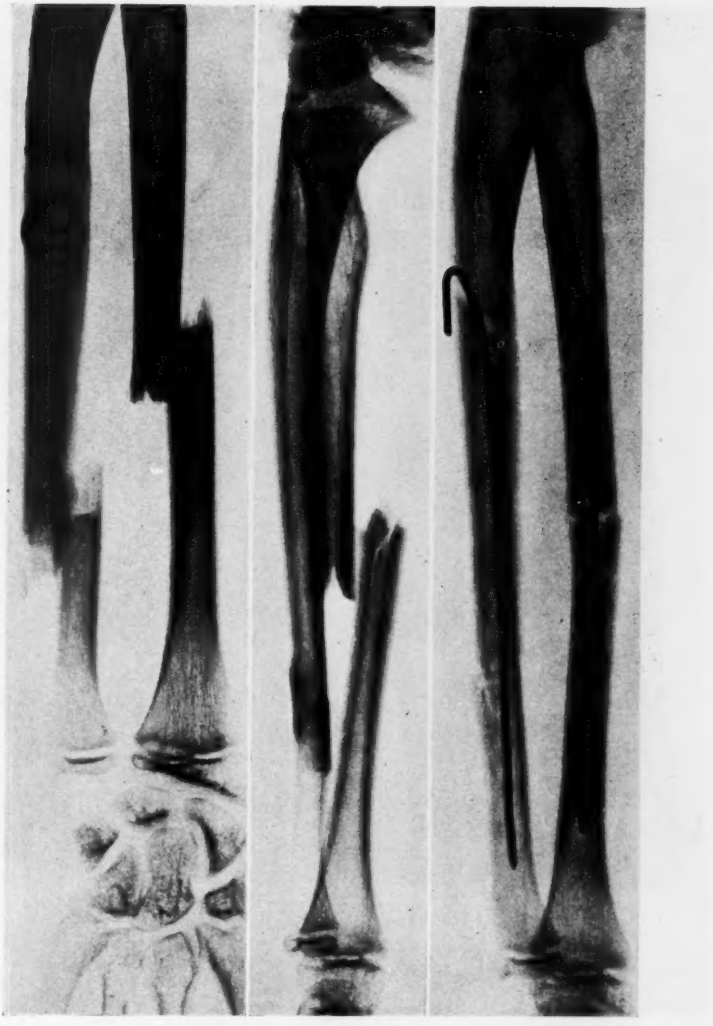
Report of Two Cases

JAMES A. DICKSON, M.D.

Everyone who has treated many fractures in the middle third of both bones of the forearm realizes the difficulty of reducing and maintaining these fractures in proper position. Even in skilled hands several manipulations may have to be carried out before a satisfactory and acceptable position can be obtained in both bones.

The use of the Kirschner wire through the lower end of the radius and the upper end of the ulna to maintain traction is attended with certain difficulties and the possibility of pin infection. Internal fixation by means of a metal plate is also a difficult procedure, particularly in children because the bones are quite small and do not lend themselves to plating.

Intramedullary use of the Kirschner wire in fractures of the clavicle has been reported on many occasions with excellent results, and it has been suggested that intramedullary use of the Kirschner wire might prove effective in fractures of both bones of the forearm. However, I cannot find any article in the literature in which this method has been previously employed for this type of fracture. In cases in which open operation was indicated in order to procure a satisfactory reduction, I found the use of intermedullary fixation so simple in application and so gratifying in result that I wish to report two cases.

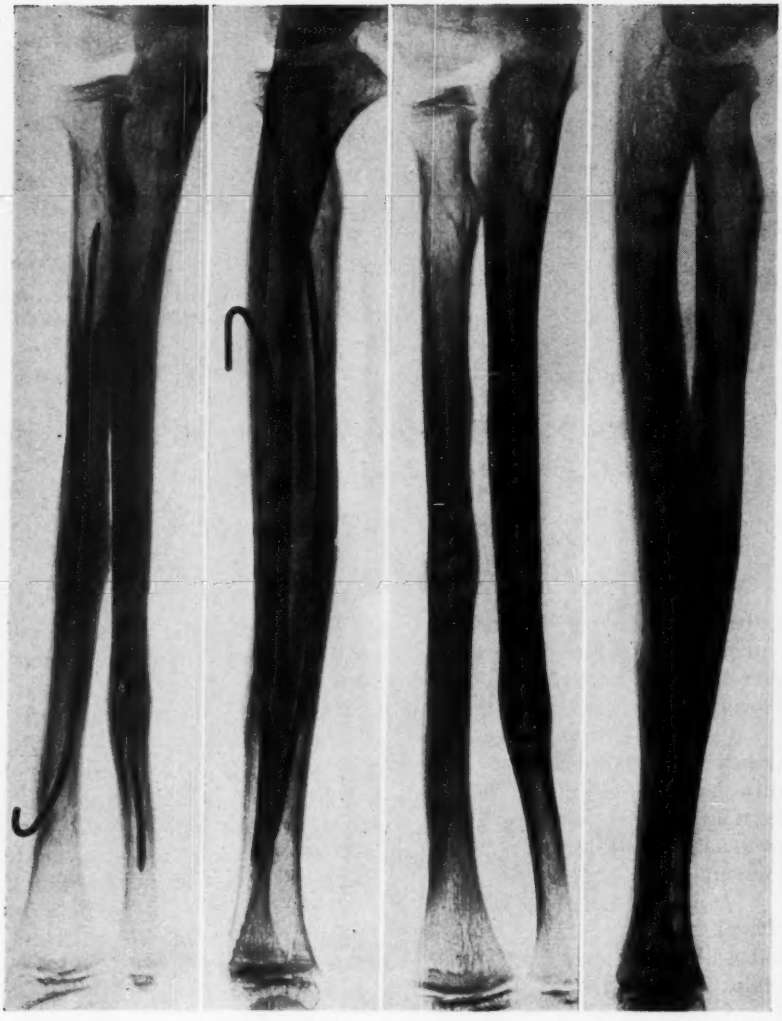


A B C

FIG. 1. Case 1. (a and b) Position of fracture after manipulations before open reduction. (c) Wire in position.

CASE REPORTS

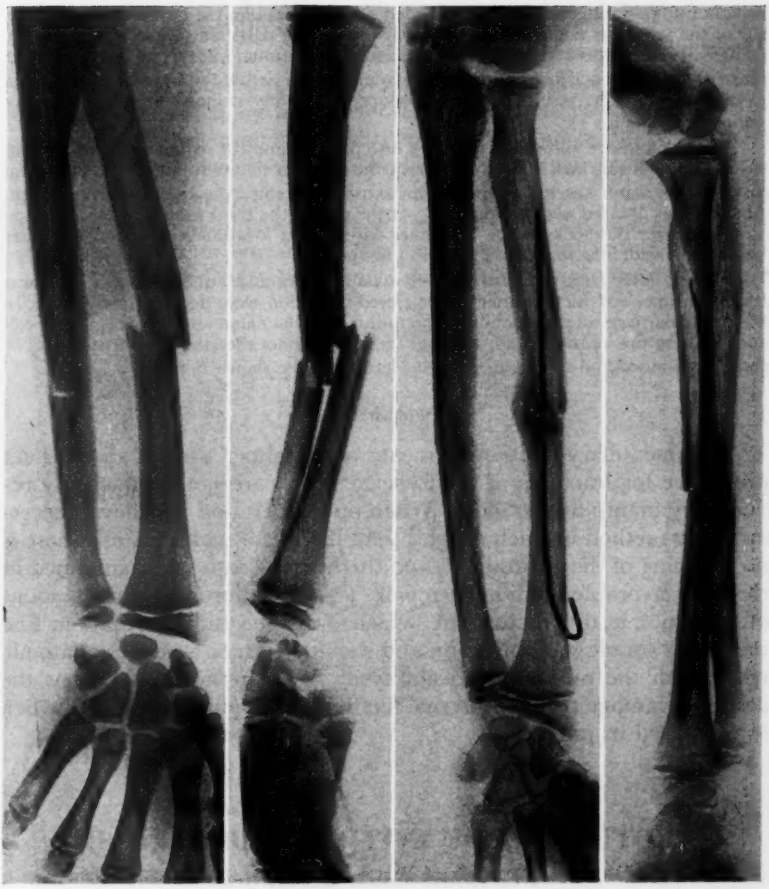
Case 1. A boy, 14 years of age, received fractures of both bones of the forearm. When he was referred to me, three unsuccessful attempts at reduction had been made



A B C D

FIG. 2. Case 1. (a and b) Excellent callus formation at the end of eight weeks. (c and d) Result at end of twelve weeks after removal of wires.

under anesthesia. The position that was obtained is shown in figure 1. The arm was very swollen, and any further attempt at manipulation seemed contraindicated.



A B C D

FIG. 3. Case 2. (a and b) Position of fragment before open reduction after open manipulation. (c and d) Position and callus formation at end of eight weeks. Wire removed under local anesthesia at end of twelve weeks.

Under anesthesia an incision was made over the fracture site of the radius, and without stripping the periosteum the fracture was reduced, the ends of the bone being held by means of bone forceps. A small incision was made over the lower end of the radius and a hole drilled into the medulla in a slanting position. Into this was threaded a Kirschner wire. The wire was slightly bent on the tip to facilitate its passage up the medullary canal. The wire was gradually eased up the canal with pliers, as the use of a drill tends to engage the point of the wire in the cortex. When the wire reached the site of the fracture, the wire outside the bone was measured. The fracture was then

brought into position, and the wire threaded 2 or 3 inches into the upper fragment. The end of the wire was cut and turned upwards over the outer surface of the bone. A similar procedure was carried out for the fracture of the ulna, but this time the wire was inserted into the upper fragment of the ulna and passed across the fracture line into the lower fragment. The results of the procedure are readily demonstrated in the x-ray photographs (figure 1).

The tissues were allowed to fall back into position and the wounds closed. A light, rather loosely fitting cast was applied from the palm to the midupper arm. The usual postoperative care was given, and when satisfactory callus formation was obtained, the child was allowed normal function. At the end of the third month a small incision was made over the hooks of the Kirschner wires under local anesthesia and the wires readily removed. The results are shown in figure 2.

Case 2. A boy, aged 13, also had two manipulations under anesthesia before he was referred to me, and further attempts at closed reduction were deemed inadvisable. In this particular case after reduction of the radius the ulna came into such excellent position that insertion of the second wire into the ulna was not thought to be necessary. The position obtained and the excellent callus formation are shown in figure 3.

SUMMARY

Intramedullary fixation by means of Kirschner wires is an excellent procedure for fractures of the forearm which are not satisfactorily reduced by manipulation alone. When open operation is believed necessary, this method is much simpler than the use of metal plates. There is no stripping of the periosteum, and the fracture ends are maintained in the most favorable position for repair. This also affords a certain amount of impaction at the fracture site, which stimulates callus formation. The method is simple in application and should produce a perfect anatomic result with the minimum possibility of any complications. It has the added advantage that the internal fixation can readily be removed when it has served its purpose.

PROTRUSION OF INTERVERTEBRAL DISK

A Common Cause of Sciatica

W. JAMES GARDNER, M.D.

Since the days of Pithecanthropus erectus, man has been paying for the privilege of walking on his hind legs. Nature designed the human body for four-legged locomotion, and evolution has not yet accomplished the structural changes required by this relatively new mode of progression. As a result, certain inherent anatomic weaknesses are expressed in the form of peculiarly human maladies. Some of the more common are flat feet, varicose veins, hemorrhoids, cystocele, hernia, backache, and sciatica. The latter condition is usually due to

posterior protrusion or rupture of the intervertebral disk immediately above or below the fifth lumbar vertebra.

A knowledge of the anatomy of the parts is necessary for an understanding of this condition (fig. 1). The mamalian spine consists of bony vertebrae separated by intervertebral disks. These cartilaginous structures are designed to give flexibility to the spine but not to bear weight. Along the anterior surface of the bodies of the vertebrae runs the longitudinal anterior spinal ligament, which is very dense and strong. The posterior spinal ligament is a less dense structure running longitudinally along the posterior surfaces of the vertebral bodies within the spinal canal. The intervertebral disk consists of two cartilaginous plates which

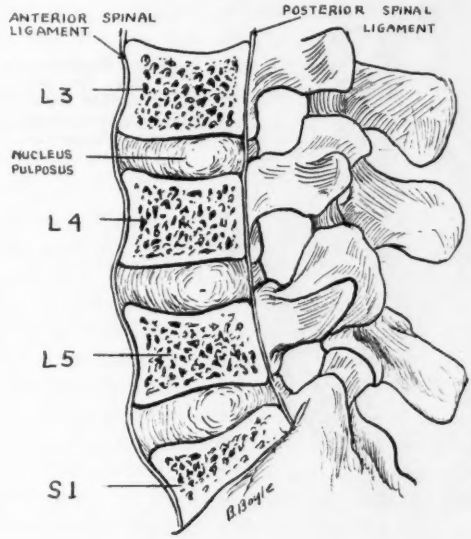


FIG. 1. Anatomy of mamalian spine showing vertebrae separated by intervertebral disks.

are adherent to the flat surfaces of the bodies of the adjoining vertebrae. The nucleus pulposus is an ovoid, semigelatinous cushion in the center of the disk, surrounded by the dense, heavy fibers of the annulus fibrosus. This annulus is thicker in front and at the sides than at the back, where together with the thinner posterior spinal ligament it forms the anterior wall of the spinal canal. The relative thinness of the posterior portion of the intervertebral disk and of the posterior spinal ligament explains the frequency with which the disk bulges posteriorly when it is compressed. These anatomic considerations also explain why protrusion of an intervertebral disk is almost invariably produced by

trauma exerted in the long axis of the spinal column and seldom, if ever, by a direct blow to the back. Since the lower portion of the spine sustains the most weight, the most frequent site of the protrusion is between the fifth lumbar vertebra and the sacrum. The next most frequent site is between the fourth and the fifth lumbar vertebra, and in perhaps 2 or 3 per cent of the cases the protrusion is between the third and the fourth lumbar vertebra (fig. 2).

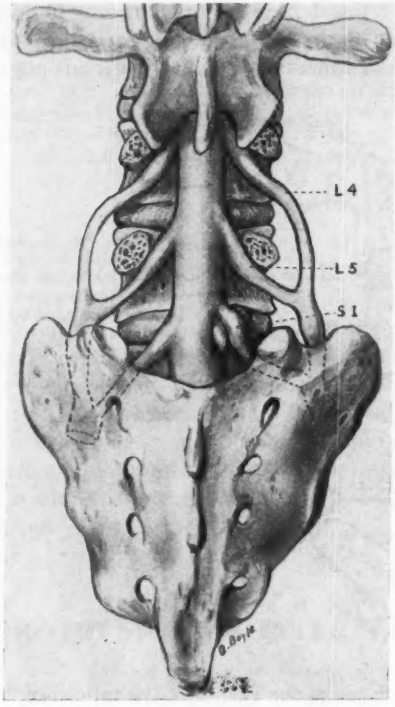


Fig. 2. Protrusion of disk between fifth lumbar vertebra and the sacrum causing pressure on first sacral nerve root.

The protrusion causes pain by compressing the nerve root above its point of exit through the intervertebral foramen. A protrusion of the disk between the fifth lumbar vertebra and the sacrum causes pressure on the first sacral nerve root; between the fourth and the fifth lumbar vertebra, on the fifth lumbar root; and between the third and the fourth lumbar vertebra, on the fourth lumbar root. Since the sciatic nerve is composed of fibers which leave the spinal canal with the third, fourth, and fifth lumbar nerve roots and the first and second

sacral nerve roots, a protrusion at any of these three levels gives rise to pain in the distribution of the sciatic nerve.

Mixter and Barr[1] in 1934 first described the clinical picture of protrusion of the intervertebral disk. Prior to that time many neurologic surgeons operated upon patients with the clinical picture of tumor of the cauda equina and found a mass of cartilaginous tissue attached to the anterior wall of the spinal canal. This was usually considered to be a chondroma rather than an extrusion of the disk. Nowadays it is the rare case of protruded disk which progresses to the stage where it causes paralysis of the cauda equina.

Protrusions of the intervertebral disk are more common in men than in women, undoubtedly because a man does heavier work than a woman. The lesions are most common in the fourth and the fifth decade. In about half the cases there is a definite history of trauma, in the remaining half the patient can attribute the onset of the symptoms to no particular trauma or strain.

HISTORY

A typical case history follows:

A man, aged 45, while lifting a heavy object suddenly feels something snap in his back. He has severe pain in the lower back and is unable to straighten up completely. After several days' rest in bed the pain gradually begins to subside, and in a few weeks he is back at work. Some months or years later he again experiences a pain in his back, with or without trauma, this time associated with a severe, sharp pain down the back of the thigh and calf on one side. Similar attacks recur at intervals of several months and may become progressively more severe and persistent. The patient states that the pain is increased by coughing, sneezing, and straining at stool. It is aggravated by bending over, and the patient does not attempt to carry any weight or to do heavy lifting. After he has been on his feet for a time, he may become aware of a numbness and tingling in the foot on the painful side. Lying down produces some relief, but even turning over in bed may be exquisitely painful.

FINDINGS

On examination the patient walks in a guarded fashion and with a limp of the affected leg. He lies down upon and arises from the examining table with great caution. When he stands the trunk is inclined to one side. The normal lumbar lordosis is lost so that the lumbar spine is flat. There is spasm of the lumbar muscles, and the patient bends forward from the hips with very little flexion of the lumbar spine. Extension and

lateral bending of the lumbar spine are usually less restricted than forward bending. There is tenderness on deep pressure over the fourth or the fifth lumbar spinous process or beside them on the same side as the sciatica. The sciatic pain is aggravated by straight leg raising, and Lasègue's sign is positive on the affected side. The affected calf is slightly smaller in circumference, and the achilles tendon reflex is absent. There is slight weakness in flexion and extension of the great toe. On careful testing with a pin slight impairment of pain perception on the outer side of the foot is revealed. When a blood pressure cuff is placed about the patient's neck and inflated to a pressure of 40 mm. of mercury with the patient standing, the sciatic pain and tingling are usually increased. Given this sort of history and these clinical findings, the diagnosis is almost unquestionably a protruded intervertebral disk.

I have found the following chart of decided help in determining which cases of low back ache and sciatic pain are caused by protrusion of the intervertebral disk.

HISTORY	FINDINGS
Type of injury	Lumbar spine
Number of previous attacks	Contour normal
Duration of present attack	Increased lordosis
Aggravating factors	Diminished lordosis
Coughing	List to one side
Sneezing	Limitation of flexion
Straining	Location of tender points
Stooping	Atrophy
Sitting	Calf
Lifting	Thigh
Standing	Gluteus
Walking	Weakness of big toe (flexion, extension)
Relieving factors	Patellar reflex
Location of pain	Achilles tendon reflex
Location of numbness	Pain on straight leg raising
	Jugular compression test
	Location of hypalgesic area

X-ray usually shows little abnormality of the lumbar spine except flattening of the normal lumbar curve. Evidence of narrowing of one of the intervertebral disks is of little significance in indicating the site of the protrusion. The dynamics of the spinal fluid are normal except in the rare case of a large protrusion completely obstructing the lower end of the lumbar sac.

If a diagnostic lumbar puncture is done, the needle should be introduced between the fifth lumbar spinous process and the sacrum;

at this level the protein content is most likely to be increased. Two cc. of spinal fluid should be removed as soon as the needle is inserted and before the pressure manometer is connected in order to obtain a specimen unmixed with fluid from a higher level. This specimen is sent to the laboratory for total protein estimation. The manometer is then connected. The Queckenstedt test usually demonstrates no evidence of block. Another specimen of spinal fluid is then withdrawn for complete study. The protein content may be a little lower in the second specimen than in the first because it is diluted with fluid from above the lesion. In about half the cases of protruded disk the total protein content of the spinal fluid is increased to between 40 and 100 mg. per 100 cc.

In the early years of surgery of the intervertebral disk most operators preferred to verify the presence and location of the protrusion by means of lipiodol or air myelograms. Nosik[2] found that thorotrast is a more accurate contrast medium than lipiodol or air. His method gives excellent delineation of the lower portion of the spinal canal. However, after using thorotrast for several years without ill effect, early in 1943 some sharp reactions occurred in patients immediately following its injection. The use of the material has therefore been discontinued.

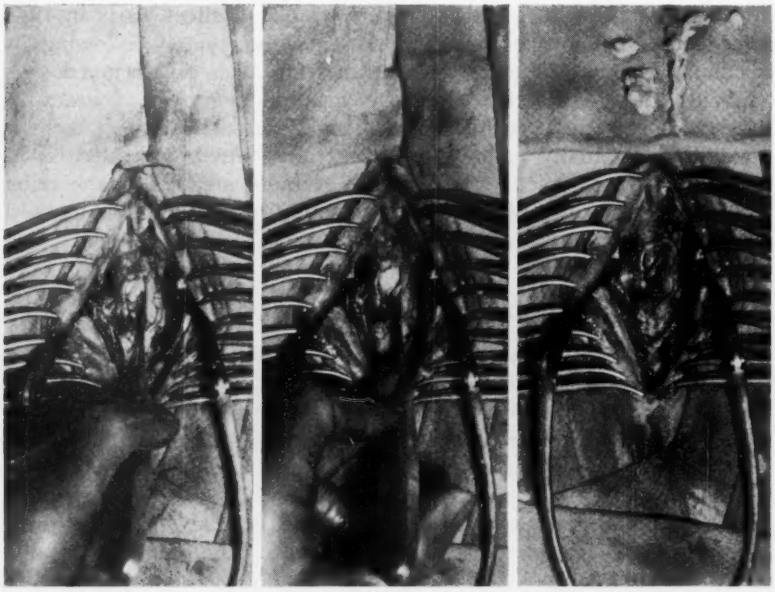
With the discontinuance of myelography diagnostic accuracy as judged by the operative findings has not suffered. However, there is no doubt that many patients with protruded intervertebral disks in whom the clinical picture is not quite definite are denied the relief which an operation could give them if an entirely dependable method of myelography were available.

TECHNIC OF OPERATION

The operation for protrusion of the intervertebral disk is carried out in the Neurosurgical Division as follows:

The patient is placed in the prone position on the operating table with a firm bolster extending from shoulder to iliac crest on each side. This provides a shallow trough for the chest and abdomen so that respiration is free and venous pressure is low. Intravenous pentothal anesthesia is administered. A linear incision is made from the third lumbar to the second sacral spinous process. The muscles are dissected from the lumbosacral spine on the side of the sciatica. The fifth lumbar spinous process and the lamina on the side of the pain are removed. The ligamenta flava above and below the fifth lumbar lamina are dissected out. By palpating the dura the operator can readily detect the firm swelling produced by the protrusion at either the fourth or the fifth interspace. The dural sac is retracted toward the midline,

and the dural sleeve containing the nerve root is exposed. The nerve is found to be stretched and flattened by a mass bulging beneath it (fig. 3-a). The nerve is retracted toward the midline from the dome of the swelling, and the firm, pale, elastic protrusion covered by the posterior spinal ligament is exposed (fig. 3-b). It is placed laterally but extends almost to the midline. With a sharp pointed scalpel the posterior spinal ligament is incised over the dome of the swelling, and a ragged fringe or mass of white fibrocartilaginous material protrudes through the incision. This is seized with grasping forceps and extricated. After the protruding portion of the disk has been removed in this fashion, a sinus leading into the interior of the disk is disclosed. The grasping forceps are introduced into this sinus, and additional loose fragments of cartilage are removed. A bone curette is then introduced into the sinus, and the cartilaginous plates above and below are curetted (fig. 3-c). Bleeding points in the extradural venous plexus are controlled by electrocautery



A B C

FIG. 3. Operative exposure of protruded intervertebral disk on the left side at the lumbosacral level. (a) Dural sac retracted to show the nerve sleeve flattened by the bulging mass beneath it. (b) The nerve sleeve retracted showing the dome-shaped swelling covered by the posterior spinal ligament. (c) The pressure on the nerve has been relieved by the removal of the cartilaginous material shown above the operative field.

or by the application of small muscle grafts. The wound is then closed with several tiers of interrupted black silk sutures without drainage. The patient is allowed out of bed on the twelfth day and is discharged on the fourteenth.

COMMENT

In the early days of the operation for protruded intervertebral disk it was customary to do a wide bilateral laminectomy. As surgeons became better acquainted with the lesion they found that it was possible to remove the protruded portion of the disk by simply enlarging the space between the laminae with a rongeur, or even in some instances without removing any bone at all. As is frequently the case, some surgeons went to the extreme and began to pride themselves on the fact that they could treat this condition with the removal of very little or no bone at all. This, to my mind, is a mistake.

I believe that an attempt to treat the condition without adequate exposure is certain to result in some cases in incomplete removal of the protruded portion of the cartilage. I therefore believe that it is better to remove the lamina of the fifth lumbar vertebra on the side on which the patient has pain; if in addition the spinous process of the fifth lumbar vertebra is removed, the exposure will be even better. This approach does not appreciably weaken the spine, it permits adequate exposure of the fourth as well as the fifth interspace, and it largely eliminates the danger of overlooking a second protrusion.

A protruded disk between the third and the fourth lumbar vertebra is rare and can usually be suspected from the clinical picture. In these cases the pain is referred to the shin, and the patellar rather than the achilles tendon reflex is diminished or absent.

The results of operation for a protruded intervertebral disk are usually very gratifying. However, in some cases the pain is incompletely relieved. This is more commonly the case with the backache than with the sciatica. Also, in perhaps 5 per cent of the cases a protrusion may recur, or another protrusion may occur at a different site requiring reoperation.

In some instances, where there is spondylolisthesis or other evidence of an unstable back, a spinal fusion may be performed after the disk has been removed. The adoption of spinal fusions after the removal of protruded disks as a routine measure is still a controversial subject. It must be borne in mind that spinal fusion lengthens the operation, prolongs the convalescence, and should be reserved for those cases in which it is definitely indicated.

In my opinion, the percentage of cases of sciatica ascribed to hypertrophy of the ligamentum flavum or to so-called "concealed disks" is

far too high. More careful selection of cases for operation and more adequate surgical exposure will serve to reduce greatly the percentage of these nebulous causes of sciatic pain.

Operation should not be advised for all patients with the diagnosis of protrusion of the intervertebral disk. It is not advisable to operate unless the patient is in a severe attack which shows no signs of subsiding spontaneously. The surgeon should remember that for thousands of years patients have been recovering from attacks of sciatica without the benefit of surgery and that they will continue to do so. Operation should be reserved for those whose pain is incapacitating and does not respond to conservative measures, or in whom attacks recur at frequent intervals.

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PAGET'S DISEASE OF SKULL COMPLICATED BY MUCOCELE OF FRONTAL SINUSES

Report of a Case

HAROLD E. HARRIS, M.D.

More than sixty years ago Sir James Paget described the bone disease which bears his name. His term, osteitis deformans, which is widely used today seems to me a misnomer; the existence of infection is doubtful and frequently there is no deformity.

In the advanced stages of the disease skeletal changes are striking, with the classic signs of massive head, reduced stature, anteriorly bowed legs, and marked kyphosis. However, advanced cases are uncommon. Less advanced cases in which the disease is localized, often limited to one bone, are seen more frequently. Although the skull has long been considered the site of greatest predilection, the spine and pelvis are frequently involved, as has been demonstrated in recent years by routine x-rays of the gastrointestinal and genitourinary tracts.

Complications. Of the many complications of Paget's disease the occurrence of fractures from minor trauma is the most common

and is often the first symptom of the disease. Neurologic symptoms result from changes in the skull as manifested by the high incidence of deafness due to bony encroachment upon the auditory nerve. Neuralgia involving chiefly the infraorbital and supraorbital branches of the fifth cranial nerve and compression of the spinal cord have also been observed. The relation of malignant tumors of the bone to this disease is not definitely established.

CASE REPORT

A white woman, aged 66, came to the Cleveland Clinic on August 20, 1942 complaining of a discharge of pus from a sinus tract in the midportion of the left upper eyelid and painless swelling over the left eye, both of four years' duration. There was also a painful swelling over the right eye of approximately two weeks' duration. She did not complain of headache. She had noticed a gradual increase in the size of her head for many years. Diplopia had been present about two years.

Laboratory tests revealed normal blood calcium and blood phosphorus levels but an elevated concentration of serum phosphatase (24 Bodanski units per 100 cc.). Results of other laboratory tests were of no diagnostic significance. Roentgenograms of the head

A B C

FIG. 1. (a) Lateral view of skull showing bone changes of Paget's disease and fluid level in frontal sinuses. (b) Anteroposterior view of maxillary sinuses showing cloudy left antrum and bone changes of Paget's disease involving left antrum and orbital region. (c) Anteroposterior view of skull showing cystic enlargement of right frontal sinus and fluid level in frontal sinus.

confirmed the diagnosis of Paget's disease of the skull and revealed a cloudy left maxillary sinus and bilateral cystic enlargement of both frontal sinuses (fig. 1). There was no other skeletal evidence of Paget's disease such as bowing of the legs or kyphosis of the spine.

Pus was removed from the left maxillary sinus by irrigation. An intranasal antrotomy under local anesthesia completely eradicated the infection.

One month later a bilateral external frontal operation of the Jansen type was performed. The anterior wall of the left frontal sinus was of eggshell thickness with dehiscence and a sinus tract leading through the left upper eyelid. A probe could be passed through this sinus tract into the frontal sinus, which was filled with thick, green pus. Upon aspiration the posterior plate was found to be intact, but there was a dehis-

cence of bone on the medial wall, which communicated with the right frontal sinus. The incision was extended over the right frontal sinus through the right eyebrow. Exploration revealed cystic enlargement of the frontal sinus and erosion of the posterior plate. The dura was exposed over an area approximately 2 cm. square. The lining cystic membranes and the bony floors of both sinuses were removed. In spite of careful search no nasofrontal ducts could be identified. An intranasal opening was made on each side through the ethmoid labyrinth and a rubber catheter extending into the nose

A B

FIG. 2. (a) Photograph showing displacement of right eye inferiorly and laterally. Pus can be seen exuding from fistulous tract above inner canthus of left eye. (b) Same view of patient six weeks postoperatively.

placed in each frontal sinus. The bone was spongy, thickened, and vascular. Bleeding was profuse throughout the operation.

The rubber catheters were removed on the twenty-first postoperative day. The infections in both frontal sinuses subsided, the palpebral fistula remained closed, and the diplopia gradually disappeared. The patient made an uneventful recovery and is now entirely symptom free (fig. 2). Upon irrigation the return from both sinuses is clear.

SUMMARY

This patient had an unusual complication of osteitis deformans, or Paget's disease of the skull. From the history and findings at operation it appeared that the patient first had Paget's disease of the skull with subsequent encroachment upon the nasofrontal ducts, followed by formation in both frontal sinuses of bilateral mucocele, which became infected.

RETICULUM CELL SARCOMA OF JEJUNUM

Report of a Case

R. S. DINSMORE, M.D., and V. C. ANCONA, M.D.

Ewing[1] in 1913 was probably the first to divide lymphosarcoma into two histologic types, (1) the malignant lymphocytoma (small round cell sarcoma) and (2) the reticulum cell sarcoma (large round cell sarcoma). It was his belief that the former originated from the lymphocyte, and the latter from the reticulum cells of the germ centers of the lymph follicles and pulp cord. Kundrat[2] was the first to isolate lymphosarcoma from other lymphatic diseases and describe its clinical characteristics.

Sarcoma of the small intestine is rare. According to some writers[3] lymphosarcoma is one of the more common sarcomas of the gastrointestinal tract. Chont,[4] in a review of specimens from 2250 necropsies and 20,603 surgical operations at the University of Oklahoma Hospital, found only 8 tumors of the small intestine, 4 of which were sarcomas.

In a review of the literature up to June 1, 1919 Graves[5] reported 166 cases of sarcoma of the small intestine. Ullman and Abeshouse[6] collected 77 additional cases up to 1932. In August 1941 Frank, Miller and Bell[7] collected 114 cases reported in the previous ten years and added 4 more.

CASE REPORT

A white woman, aged 58, seen on January 7, 1944, complained of loss of appetite of two months' duration, vomiting for three weeks, and pain in the abdomen for several weeks. Apparently she was in good health until six months before admission, when she began to complain of a feeling of fulness and a dull, aching pain in the epigastrium. About four months later her pains became more frequent and more persistent, and her appetite began to fail. Vomiting was present for three weeks before admission and often occurred shortly after eating. In six months she lost 7 pounds, and according to her own report she had lost 53 pounds in two years.

The family history, the history of past illnesses, and symptoms were not significant.

Physical examination revealed a slight pallor. On abdominal examination a firm, tender, movable mass was palpable just to the right of the umbilicus. There was tenderness and slight spasticity along the right margin of the rectus muscle. Examination of the rectum was normal.

The red cell count was 3,760,000 with hemoglobin of 43 per cent, and white cell count was 5300. Total serum proteins measured 4.8 Gm. per 100 cc. Blood urea and chlorides were normal, and the blood sugar was slightly above normal.

X-ray examination of the small intestine with opaque barium revealed on the right side of the abdomen opposite the fourth lumbar vertebra marked narrowing of a seg-

ment of the upper jejunum, which measured about 12 cm. in length. The intestine proximal to this lesion was dilated.

On February 9, 1944 laparotomy was performed. A mass involving the midportion of the jejunum was immediately revealed. The surface of the jejunum was smooth and glistening, but the wall was thickened, indurated, and replaced by white, soft tissue resembling lymphosarcoma. The involved portion of the intestine was resected and a side to side anastomosis performed.

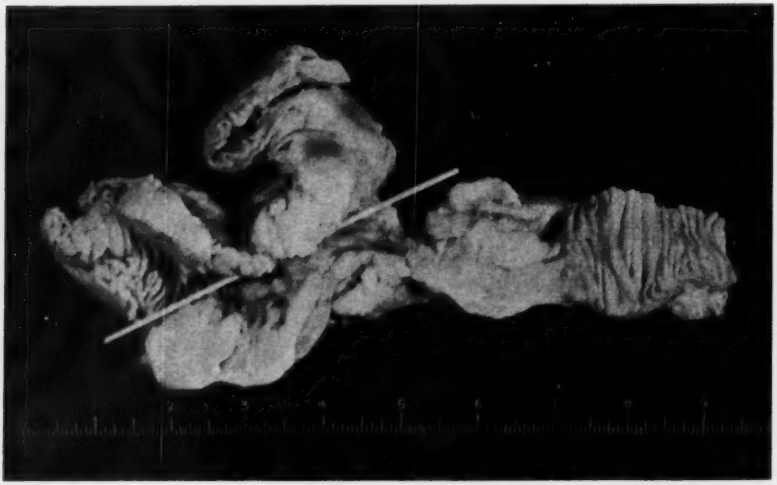

Figure. Reticulum cell sarcoma of jejunum with probe demonstrating marked narrowing of lumen of jejunum.

Pathologic Findings. The specimen consists of a midportion of the segment of jejunum with attached omental fat (figure). The segment measures 30 cm. in length. A tumor mass consisting of two nodules is located in the center of this segment. The serosa is pinkish white in color and fairly smooth. The tumor area is whitish gray and firm. In the center of the tumor mass is a considerable amount of stenosis causing almost complete obstruction and admitting a probe the size of a lead pencil. The segment is opened longitudinally along the anti-mesenteric border; a large tumor growth involves 16 cm. of the segment encircling the entire circumference and practically the entire mucosa. The largest tumor mass measures 2.6 cm. in thickness. The tumor is soft, very smooth, cellular, and greyish white in color. Throughout the lumen some necrosis appears to be present. In the omental fat are twelve rather firm, small lymph nodes.

The tumor involves the entire wall of the jejunum. It consists of a diffuse, fine mesh of large, slightly varied, stellate cells with no stroma other than that accompanying small blood vessels. The cells have scant cytoplasm, partly eosinophilic and partly basophilic. The nuclei are large, round, oval, uniform and irregular, hyperchromatic, and vesicular. Most have large nucleoli. Up to twenty, often atypical, mitotic figures are seen in high power field. In the mucosa replaced by tumor are a few persistent crypts of Lieberkühn, and strands of smooth muscle occur in the region of the muscularis; other-

wise all normal structures have been replaced. The serosa is thickened by tumor, which is limited externally by fibrous tissue, mesothelium, and a few strands of fibrin. An adjacent portion of jejunum shows chronic inflammation of fourteen lymph nodes; one shows complete and another almost complete replacement by tumor like that in the jejunum, with the tumor breaking through the capsule. The other nodes show slight follicular hyperplasia, fibrosis, and chronic inflammatory infiltrate.

Reticulin preparations of the tumor show networks of fine fibrils between and apparently within the cytoplasm of tumor cells in some areas.

Pathologic diagnosis:

(1) Reticulum cell sarcoma of jejunum with metastasis to mesenteric lymph nodes
(2) Chronic jejunitis
(3) Chronic hyperplastic lymphadenitis (mesenteric)

The postoperative course was uneventful, and the patient was discharged about two weeks after operation February 24, 1944. After discharge a series of x-ray treatments was applied to patient's abdomen and lumbar and sacral regions.

SUMMARY

A case of reticulum cell sarcoma (lymphosarcoma) of the jejunum has been reported, characterized by an insidious onset, and followed by symptoms of obstruction. A palpable mass was later found to involve the entire wall of the midportion of the jejunum and to cause marked stenosis.

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NARCOLEPSY AND CATAPLEXY

Report of Two Cases

R. H. McDONALD, M.D.

Narcolepsy is a term suggested by Gélineau[1] in 1880 to designate an uncontrollable desire for sleep resulting in a trancelike state of varying duration indistinguishable from normal sleep. This occurs under condi-

tions not ordinarily conducive to normal sleep. Cataplexy is a term suggested by Henneberg[2] to describe loss of muscle tone without loss of consciousness occurring in response to an emotional stimulus. This state is characterized by complete muscular atony, by absence of deep reflexes, and occasionally by a positive Babinski sign. The term cataplexy must be distinguished from the more common term catalepsy, which designates the state of muscular rigidity in the catatonic form of schizophrenia and in hysteria. The narcoleptic and the cataplectic syndromes may coexist in one person. Brock and Wiesel[3] suggest that they are abnormalities of the two component parts of normal sleep: lack of mental awareness and sympathetic nervous relaxation.

Clinically, narcolepsy usually precedes cataplexy. A period of marked muscular weakness, such that the patient is unable to carry out voluntary motion, may occur either before or after the narcoleptic seizure. Both normal and narcoleptic sleeps in these patients may be accompanied by nightmares, sleepwalking, and sleeptalking.

The narcoleptic-cataplectic state appears in many respects to be merely an exaggeration of the normal reaction. Almost everyone has experienced sleepiness when listening to a dull, uninteresting lecture, and a sense of muscular weakness is exceedingly common under intense emotional strain.

CASE REPORTS

Case 1. A man, aged 27, was first seen at the Clinic on August 14, 1943. He complained of compulsive sleepy spells occurring daily during the previous year. These developed suddenly without obvious cause. A period of semiconsciousness was followed by sound sleep lasting from ten minutes to two hours. He was told that during semiconsciousness his pupils contracted. Upon waking he felt well but sometimes had forgotten what he was doing when the attack began. The attacks were never accompanied by convulsive movements.

He had insomnia frequently and sat up smoking a large part of the night. When asleep he was often wakened by a sensation of pulling or jerking in the abdomen. Persistent nocturnal erection occurred. The patient complained of severe recurrent headaches during the preceding year. These were referred to the occipital and suboccipital regions and were associated with a tight, full feeling in the head. He noted extreme muscular weakness under emotional stress.

For the preceding three years the patient had worked under great tension attempting to build up his own business. There was no history of head injury or brain inflammation. Except for measles, mumps, and chicken pox in childhood, he had been in good health.

General physical examination revealed a well developed, well nourished adult. Temperature was 98.8 F., pulse 84, blood pressure 130 systolic, 85 diastolic. The pupils were small and equal, and reacted to light and in accommodation. Optic disks were clearly outlined, and retinae appeared normal. There was no thyroid enlargement. Chest appeared normal, heart was of moderate size, and heart sounds were regular and

rhythmical. There was no enlargement of liver, kidneys, or spleen, and there were no abdominal masses. The rectal sphincter was spastic. Prostate was of normal size and firmness. Upon neurologic examination cranial nerves appeared intact, tendon reflexes normal, and there was no evidence of sensory or motor change. Examination of the nose and throat revealed some deviation of the nasal septum and some evidence of catarrhal rhinitis. Tonsils had been removed, tongue was normal, and teeth showed good dental repair.

Results of routine laboratory tests, including urinalysis, blood count, blood sugar, and blood Wassermann, were all within the normal range. Upon x-ray examination the skull was entirely normal. The pineal gland was densely calcified, but the sella turcica and the petrous pyramids were normal.

A diagnosis of narcolepsy and cataplexy was made. The patient was directed to take 10 mg. of benzedrine sulfate twice daily, after breakfast and after lunch. Since little improvement was noted after ten days, the dosage was increased to 30 mg. daily, to be taken before 2:00 p.m. Considerable improvement resulted from this medication, but the patient was also given 1½ grains of dilantin twice daily because of undue stimulation from the benzedrine. He was advised to obtain more rest and to establish regular living habits. Medication combined with a more rational regimen produced definite improvement.

Case 2. A woman, aged 22, came to the Clinic on April 5, 1944 complaining of spells of sleepiness. These began eight years previously when she was in high school and continued during her college years when she frequently fell asleep in class. Almost from the onset she noted a lack of muscular tone when laughing or when under emotional stress. She believed that a high carbohydrate diet increased this weakness. Although she believed that the symptoms were subsiding, they interfered with her work as a dental assistant.

Apart from measles and whooping cough in childhood, her general health history was very good.

General physical examination revealed a well developed, well nourished adult. Temperature was 98.4 F., pulse 80, blood pressure 106 systolic, 76 diastolic. Pupillary reactions were normal. Optic disks were clearly outlined, and retinae were normal. Maxillary sinuses were transilluminated clearly, ear drums normal, and tongue normal. There were no dead teeth and only a small amount of dental repair. Tonsils were of moderate size. There was no thyroid enlargement. Breasts were normal. Chest was clear, the heart not enlarged, heart sounds regular and rhythmical. No enlargement of liver, kidneys, or spleen was noted, and there were no abdominal masses. Pelvic viscera appeared normal upon examination per rectum. Back was flexible and not tender. Neurologic examination showed the cranial nerves normal, the tendon reflexes normal, and no evidence of sensory or motor change. Results of routine laboratory tests, including urinalysis, blood count, blood sugar, and blood Wassermann and Kahn, were within the normal range.

A diagnosis of narcolepsy and cataplexy was made. The patient was directed to take 10 mg. of benzedrine sulphate and ⅜ grain of ephedrine sulphate twice daily, after breakfast and after lunch. Considerable improvement resulted from this medication.

COMMENT

The pathologic basis of the narcoleptic-cataplectic syndrome is not established because postmortem studies are lacking. According to

the consensus, the syndrome is the result of an organic defect, possibly related to the sequelae of encephalitis or meningitis, or associated with neoplasm. The sleep-regulatory mechanism is believed to be in the posterior hypothalamic region, but some symptoms suggest involvement of the upper midbrain. Lack of consciousness in a narcoleptic attack indicates possible involvement of the cerebral cortex as well.

The term narcolepsy suggests a relation with epilepsy, but there is no evidence of common etiology although the attacks in the two conditions are somewhat similar. There is no record of a patient with narcolepsy developing epilepsy. According to Dynes,[4] electroencephalographic studies reveal little difference between persons in normal sleep and those in a narcoleptic attack, in contradistinction to the abnormal electrical discharges from the brain of an epileptic patient. Furthermore, narcolepsy is best controlled by stimulating drugs such as ephedrine and benzedrine, whereas epilepsy is best controlled by sedatives.

The narcoleptic-cataplectic syndrome may persist for many years with periods of remission. Ephedrine and benzedrine may modify its course, but medication must be continued over long periods of time. Attention to the general health is of considerable importance. Apparently the condition does not shorten life.

SUMMARY

Two cases of the narcoleptic-cataplectic syndrome are reported. It is characteristic that these patients present no definite neurologic signs, although they present symptoms which are sometimes observed in patients with organic brain lesion. Treatment with stimulating drugs, chiefly benzedrine and ephedrine, does much to alleviate symptoms. The condition has no apparent relation to epilepsy, and the prognosis is generally good although the symptoms may persist through life.

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MEDICAL PHYSICS II

Radiation Therapy

OTTO GLASSER, Ph.D.

The close relation of physics and medicine is illustrated in the development of x-ray and radium therapy. Twenty-five years ago roentgen rays were produced by temperamental gas tubes connected to transformers with mechanical rectification. The maximum potential was about 130,000 volts. Roentgen ray output was erratic and not easily reproduced; only with great difficulty could the amount and the kind of radiation be estimated. Transfer of a given dosage from one machine to another was a problem since the outputs of two machines might vary widely, even though such technical factors as voltage, amperage, distance, and filter were identical. The common methods of calculating dosage from these factors alone were therefore often condemned to failure.

Physicists and radiologists working together steadily improved x-ray apparatus and methods of treatment.[1,2,3,4] Modern generators produce potentials up to several million volts, and hot filament x-ray tubes operate on these high potentials. Radiation output is constant and reproducible. Today both quantity and quality of radiation can be readily and accurately determined.

Roentgen ray quantities are expressed in an internationally accepted dosage unit, the roentgen; the unit of quality is the half value layer, which classifies x-rays according to their penetrating power. Absorption and scattering of x-rays within the body have been studied for many radiation qualities and for numerous therapeutic technics. The results of these studies have been arranged in convenient tables from which surface doses, depth doses, and exit doses for the patient are quickly ascertained. Numerous clinical and biological dosages have been determined in roentgens. Thus the basic factors in production and application of roentgen rays are now well understood and controlled by the radiologist.

The essential features of radium therapy have likewise been explored and data classified within the past twenty-five years. Radium and its decay products emit alpha, beta, and gamma rays, all of which are used in radium therapy.

Alpha rays are a stream of positively charged helium nuclei; they have a large mass and are easily stopped by a few centimeters of air

or by less than 1 mm. of skin. In one form of alpha ray therapy an ointment containing radon is applied to the skin.[5]

Beta rays are electrons. They have various energies and can penetrate 1 cm. of tissue; they are completely stopped by 0.5 mm. of platinum filter or its equivalent. Beta ray therapy, which is also superficial, employs radium plaques or thin-walled glass tubes filled with radon.[6]

Gamma rays, like x-rays, are photons and have much greater energy than the easily absorbed alpha and beta rays. To produce x-rays of the same quality as the most penetrating gamma rays of radium would require about 3 million volts. If sufficient radium were available to duplicate common deep x-ray therapy technics which require about 200,000 volts, much greater depth doses would be obtained with the radium. However, about 360 Gm. of radium, one-third the total produced since its discovery, would be needed to produce an intensity of about 20 roentgens per minute at a distance of 50 cm., which is customary with x-rays. To compensate for small amounts ordinarily available, the radium must be brought closer to the skin, with a consequent loss of the relative depth dose. The loss is not caused by any change in penetrating power of the rays but is purely geometric and is governed by the inverse square law. In external gamma ray therapy, so-called teletherapy, the radium or radon in applicators of various sizes and shapes is placed at certain distances from the skin.

Corresponding to the surface application of radium is the Chaoul and Philips x-ray technic [2,3,4] in which the windows of the x-ray tubes are brought into close contact with the skin. These tubes are operated at about 60 kilovolts and consequently do not give out rays as penetrating as gamma rays; however, with this technic only superficial action of the rays is intended.

Two other gamma ray technics are used: Intracavitary radium therapy employs radium or radon tubes singly or in combinations of two or more. In interstitial radium therapy various types and forms of radium or radon implants are left in place permanently or removed after a time.

Dosage for these three types of gamma ray therapy depends upon the amount of radium or radon used, the kind of filtration, and the shape and geometric arrangement of the applicators. Determinations and interrelations of dosages for a great variety of technical conditions have been charted and tabulated by physicists and radiologists. The most generally used tables are those of Paterson and Parker.[2] These tables have been simplified by adoption of the gamma roentgen, a

dosage unit for gamma rays of radium analogous to that for roentgen rays. An older unit for gamma ray therapy, the milligram element hour, is related to the gamma roentgen, since 1 mg. of radium element filtered by 0.5 mm. of platinum at 1 cm. distance emits 8.5 gamma roentgens per hour. Clinical and biological dosages expressed in gamma roentgens have been gathered empirically for a large number of treatment conditions.

SUMMARY

Through close collaboration of the physicist and radiologist dosages have been standardized for the various forms of x-rays and radium therapy.

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EXHIBIT ON BERYLLIUM POISONING

Poisoning from fumes and dust incident to the extraction of beryllium from beryl ore was the subject of an exhibit prepared for the American Medical Association Convention in Chicago, June 12-16, by Dr. H. S. VanOrdstrand and Dr. C. R. Hughes of the Cleveland Clinic, Dr. Morris G. Carmody of Painesville, and Dr. J. DeNardi of Lorain.

Chemical pneumonitis, tracheobronchitis, nasopharyngitis, dermatitis, and conjunctivitis occurred in workers in two plants of the beryllium industry located in northern Ohio. Investigation did not reveal a specific cause for the disease, but the available evidence indicated that the poisoning might be due to beryllium salts such as beryllium sulfate.

The exhibit gave a résumé of the history, production, and use of beryllium, as well as a display of the various beryllium salts and end products.

The clinical manifestations of the disease and the areas affected were depicted by diagrammatic drawings and kotavachrome prints. The characteristic roentgen findings in chemical pneumonitis were illustrated by roentgenograms showing the progress of the disease. Colored microphotographs of lung tissue and a chart showing the results of chemical analysis of the lungs illustrated the pathology.

The exhibit was awarded a Certificate of Merit in Group I for exhibits of individual investigation judged on the basis of originality and excellence of presentation.